Commitment versus Discretion in a Political Economy Model of Fiscal and Monetary Policy Interaction

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Abstract Price commitment results in lower welfare. I explore the consequences of price commitment by pairing an independent monetary authority issuing nominal bonds with a fiscal authority whose endogenous spending decisions are determined by a political economy model. Without price commitment, nominal bonds are backed by a new form of endogenous commitment that overcomes time inconsistency to make tax smoothing possible. With price commitment, nominal bonds will be used for both tax smoothing and wasteful spending. Price commitment eliminates monetary control over fiscal decisions. I show that the combination observed in advanced economies of a politically distorted fiscal authority and an independent monetary authority with nominal bonds and without price commitment is the solution to a constrained mechanism design problem that overcomes time inconsistency and results in the highest welfare.

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1 Introduction

Kydland and Prescott (1977) and Barro and Gordon (1983)[1]find that price commitment results in higher welfare in models with benevolent fiscal and monetary authorities and nominal bonds. I find the opposite: price commitment leads to lower welfare. I change the benevolent fiscal authority to one microfounded in a political economy model. This makes fiscal decisions endogenous to the environment and nominal bond level. If the monetary authority commits to a price level the politically distorted fiscal authority will spend with impunity leading to a welfare loss.

In models with benevolent fiscal and monetary authorities price commitment leads to welfare gains because it overcomes the time inconsistency problem of nominal debt: a benevolent monetary authority with discretionary policy will inflate away the real value of nominal debt at the start of every period, allowing the benevolent fiscal authority to set taxes to the minimum. Consumers anticipate this inflation and won't hold bonds because their real value will evaporate. Thus nominal bonds will not exist. Price commitment eliminates the benevolent monetary authority's ability to inflate; equivalently it turns nominal bonds into indexed bonds. The benevolent fiscal authority can then use bonds to increase welfare by smoothing taxes as shown in Barro (1979).

The benefit of price commitment is stark: no bonds with discretionary policy versus the benevolent optimal amount of bonds with price commitment. I show in this paper that a politically distorted fiscal authority is able to issue nominal debt without price commitment. Now the benefit of price commitment is not as stark: bonds for tax smoothing with discretionary policy versus bonds for tax smoothing and wasteful spending with price commitment. Additionally, the cost of price commitment will be positive: price commitment removes the the threat of inflation the monetary authority uses to constrain spending by the fiscal authority. With price commitment, a politically distorted fiscal authority is able to issue bonds to fund wasteful spending that will require higher taxes in the future to pay off.

In the course of proving the new result about price commitment, I provide new answers to two other questions of monetary economics: why do governments issue nominal debt, and why is an independent central bank desirable. The analysis shows

[1]These papers deal with the time inconsistency problem of nominal debt in models with a Phillips curve rather than directly through the government's budget constraint. The time inconsistency problem is identical.

that nominal debt provides a method for an independent central bank to discipline a politically distorted fiscal authority. In return, the politically distorted fiscal authority overcomes the time inconsistency of nominal debt by anchoring expectations that the central bank won't monetize the debt. I show that pairing a politically distorted fiscal authority and an independent monetary authority is efficient. It can be viewed as the result of a constrained mechanism design problem that seeks to overcome time inconsistency while minimizing any political distortion.

I use the political economy model of Battaglini and Coate (2008) to rationalize fiscal decisions with microfoundations. The government tries to maximize the utility of a subset of the citizens instead of maximizing the utility of the society as a whole. A politically distorted fiscal authority will, when it has little debt, spend on private transfers to its coalition rather than on public goods.

An independent benevolent monetary authority knows that inflating away the real value of nominal debt will give the politically distorted fiscal authority budgetary freedom to spend revenue on private transfers rather than on public goods. Maintaining a positive level of nominal debt constrains wasteful spending, but if debt is too high it requires high distortionary taxes to pay off. Thus a form of endogenous price commitment arises: the independent monetary authority will inflate away some of the debt, so that taxes will be lower, but not all of the debt. The remaining debt will be enough to prevent the distorted fiscal authority from wasting revenue on transfers.

Endogenous commitment allows the independent monetary authority to control the spending decisions of the politically distorted fiscal authority. This commitment has two beneficial effects: it alleviates time inconsistency and it limits the power of the political distortion. Pairing a politically distorted fiscal authority with an independent monetary authority allows the fiscal authority is able to issue nominal bonds. The bonds increase overall welfare because they enable tax smoothing.

Forcing the central bank to commit to a price level in advance increases the amount of nominal bonds that can be issued. This extra revenue will be spent at the discretion of the politically distorted fiscal authority. The benefits of the extra revenue will not outweigh the future increases in taxes that will be necessary to pay off the bonds. Welfare will be lower because of these higher taxes.

If control of the monetary authority is captured by the politically distorted fiscal authority the economy will be subject to the time inconsistency problem as before. The government won't be able to issue any nominal debt. Thus central bank independence is key to separate the (benevolent) goals of the monetary authority from the (politically distorted) goals of the fiscal authority.

The rest of the paper provides the model and comparisons of the different forms of fiscal policy and price commitment. In Section 2 I review the relevant literature on the subject. In Section 3, following the analysis above, I show a benevolent fiscal authority is unable to issue nominal bonds while a self-interested fiscal authority is able to do so. Welfare is higher in the latter situation since the bonds may be used for tax smoothing. I add price commitment to the monetary authority so nominal debt becomes equivalent to indexed debt. A benevolent fiscal authority can now use bonds to smooth taxes while a self-interested fiscal authority can issue more bonds to fund larger direct transfers. In the former situation, society is better off with commitment, in the latter situation it is not. In Section 4 I show that the combination of a self-interested fiscal authority, a benevolent monetary authority and nominal bonds is the welfare maximizing setup for monetary and fiscal policy. And finally, Section 5 concludes.

2 Literature Review

The benefit of government debt as a way to smooth taxation is originally seen in Barro (1979). Debt provides an intertemporal link between good times and bad times and allows tax rates to remain constant despite variable economic conditions. This will be the positive use of bonds in this model. The revenue raised from bonds will be available for tax smoothing, as well as other more wasteful uses.

Time inconsistency prevents the use of nominal bonds. It is examined in Kydland and Prescott (1977). Time inconsistency specifically of joint monetary and fiscal policy is investigated in Lucas and Stokey (1983) and Barro and Gordon (1983). These papers show that the lump-sum nature of the inflation tax strictly dominates any other revenue generating tax instrument. The availability of the inflation tax creates an incentive for the monetary authority to inflate and thus the time inconsistency problem. I duplicate this result before the introduction of a political distortion. After its introduction, the time inconsistency problem is partially solved.

The benefit of price level commitment as a method of overcoming time inconsistency is investigated in numerous papers. A good overview of results is found in Chari et al. (1991). Price level commitment is in the form of a Ramsey plan: the central bank can choose the price level for all periods in advance ignoring time inconsistency. Price level commitment is shown to increase utility by supporting bonds to smooth taxes. While this is still a use of bond revenue, I show that price level commitment can lead to decreased utility by leading to wasteful spending by the fiscal authority. More bonds requires higher taxes in the future and thus lower overall utility.

Overcoming time inconsistency without explicit exogenous commitment is investigated for various functional forms of utility in Albanesi et al. (2001), Alvarez et al. (2004), and Díaz-Giménez et al. (2008). These papers balance the direct utility costs of inflation with the budget benefits. Persson et al. (1987) starts a literature that uses the term structure of nominal debt to the same effect. I mitigate time inconsistency in a new way founded in the differing goals of monetary and fiscal policy. Time inconsistency still dominates until the utility functions of the two are separated.

The idea that differing utility functions can result in an overall better outcome is the mechanism in Rogoff (1985a). He investigates how differing utility functions can be beneficial in an international context. Countries can cooperate by matching monetary policy moves and hence holding exchange rates constant. This gives a greater incentive to inflate which figures into consumers' expectations of inflation and leads to actual inflation. If the countries compete, monetary policy is constrained because the negative effects of exchange rate fluctuations dominate gains from inflation. I use a similar dynamic between utility functions to mitigate time inconsistency albeit between monetary and fiscal authorities rather than countries. His result that cooperation leads to worse outcomes is similar to the result I obtain.

Martin (2011) investigates what microfounding money in the method of Lagos and Wright (2005) does to price level commitment. He finds that price level commitment no longer has significant effects. I use the cashless limit where money doesn't appear directly. A version with a cash-in-advance constraint as in Lucas and Stokey (1987) doesn't change results significantly.

Another analysis of monetary policy is found in Rogoff (1985b). This work sees the advantage in monetary policy having a different utility function from the consumer. By making the central banker more inflation averse than consumers, consumers limit their inflation expectations. An overview of the benefits of a conservative central banker is found in Fischer (1995). Adam and Billi (2008) present a more modern model with independent fiscal and monetary policies built around a conservative central banker. I don't rely on a conservative central banker (which is equivalent to a form of price commitment). I microfound the split in utility functions between the monetary and fiscal sides of the economy. The difference is not from exogenous preferences (as with a more conservative central banker) but directly from the effect of political distortion on fiscal policy. Having distinct utility functions for monetary and fiscal policies provides a similar benefit in limiting consumers' inflation expectations.

The fiscal policy model used in my paper, and its political distortion, is adapted from a series of papers Battaglini and Coate (2008), and Barseghyan et al. (2013). They use an infinite period model with a political distortion from Baron and Ferejohn (1989) in which a subgroup of citizens controls fiscal policy. There is no monetary policy so their bonds are indexed. They show that this model results in debt dynamics that match the broad outlines of modern U.S debt dynamics. Azzimonti et al. (2010) uses the basic model to analyze the welfare implications of a balanced budget amendment.

Bohn (1988) explains the role of nominal debt as a hedging device against unexpected shocks. In a recession the government would like to increase spending but would prefer not to raise taxes. Inflation provides real revenues without the distorting effects of taxes. This explains the time inconsistency problem as one of balancing the benefit of hedging against the cost of inflation. Nominal bonds allow hedging but they lead to inflation. My paper endogenizes this result by endogenizing bond choices. Nominal debt is used because it affords the monetary authority limited control over the fiscal authority. This restricts the extent to which the political distortion affects fiscal choices.

The idea that fiscal and monetary policy interact through the government budget constraint is found in Sargent and Wallace (1981). To make the budget constraint hold, the fiscal authority can force the hand of the monetary authority to inflate away bonds or the monetary authority can force the fiscal side to increase revenues. The dynamic is magnified in my paper. The choices of fiscal policy are not static; the amount of spending is a function of debt and current conditions. Monetary choices will constrain the fiscal side by limiting its budget constraint through price level manipulations.

A considerable amount of study of monetary and fiscal interactions has centered on the Fiscal Theory of the Price Level as seen in Leeper (1991). It proposes that the fiscal authority can set the price level by changing the present value of expected future tax revenue and thus how much money consumers expect to be repaid for their bonds. For an overview see Bassetto (2008) or Christiano and Fitzgerald (2000). The default timing I examine, monetary policy setting the price level before the fiscal authority sets tax revenue is roughly analogous to Leeper's active monetary, passive fiscal regime. The other possibility is fiscal policy moving before monetary policy. I find that a full Fiscal Theory of the Price Level type result requires an explicit fiscal commitment as in Schmitt-Grohé and Uribe (2000).

3 The Model

Nominal government debt, when sustainable, links periods. Fiscal policy consists of setting taxes, expenditure on a public good, direct transfers to citizens, and nominal bond issuance. The timing in a period is as follows: a real shock determines wages (and the distortion due to taxes) at the beginning of every period. After the shock, the monetary authority sets the price level, then the fiscal authority chooses its policy.

3.1 Consumers

There are n identical consumers, indexed by i when necessary. A consumer's per period utility function is

$$u(c, g, l) = c + A\log(g) - \frac{l^{1+1/\epsilon}}{\epsilon + 1}$$

and they seek to maximize $U = \sum_t \beta^t u(c_t, g_t, l_t)$ where c is a consumption good, g is government spending on a public good, l is labor, and β the discount rate. The parameter $\epsilon > 0$ is the Frisch elasticity of labor. Variables without a superscript refer to period t while variables with a prime refer to variables in period $t+1$.

A representative consumer i in period t faces the budget constraint

$$c + q\left(\frac{B'}{n}\right) \leq w_\theta l(1-\tau) + \frac{\left(\frac{B}{n}\right)}{P(B)} + T_i$$

The consumer can consume c or purchase nominal bonds $\frac{B'}{n}$. Every consumer holds an identical amount of bonds so the total amount of bonds is B'. The consumer's income consists of labor income at wage w_θ that is taxed by the government at distortionary tax rate $0 \leq \tau \leq 1$ and direct transfers $T_i > 0$ from the government. $P(B)$[2] is the price level determined by the monetary authority at the start of the period. For simplicity the price level in the current period will at times be abbreviated $P = P(B)$ and the price level in the next period as $P' = P(B')$. Because P' will deflate one period bonds and all other quantities are real, the current price level P does not matter. The ratio of current to next period price level determines returns hence normalizing the current price level to 1 has no effect

Combining these equations I derive the equilibrium bond price

$$q = \beta E_\theta \left[\frac{1}{P'} \right]$$

where the expectation is over realizations of the wage w' in the next period. A consumer's utility is defined entirely by the government's choices of taxation τ and public good spending g. The simplified indirect utility function is

$$W_\theta(\tau, g) = \frac{\epsilon^\epsilon (w_\theta(1-\tau))^{\epsilon+1}}{\epsilon+1} + A \log(g)$$

3.2 Firms

The representative firm has a linear production technology

$$z = w_\theta l$$

used to produce an intermediate good z at wage w with labor l. At the beginning of each period an i.i.d. technology shock hits the economy such that wages $w_\theta \in \{w_l, w_h\}$ where $w_l < w_h$. The probability that $w_\theta = w_h$ is π, the probability that $w_\theta = w_l$ is $1 - \pi$.

The intermediate good z is split costlessly between the consumption good c and the public good g such that

$$c + g = z.$$

[2]The price level is described as a function of B rather than $\left(\frac{B}{n}\right)$ because it is a choice of the monetary authority rather than consumer. Results are identical for $\left(\frac{B}{n}\right)$ with a few extra multiplications by n. For a greater explanation of $P(B)$ see Section 3.4

This defines the per period resource constraint

$$c + g \leq w_\theta l.$$

3.3 Government

The government controls fiscal policy. Raising revenue is possible via a distortionary labor tax τ and selling nominal bonds B'. A positive bond level B means the government is in debt hence owes money to consumers. Revenue can be spent on a public good g that benefits all n citizens or on strictly positive transfer payments T_i that benefit individuals. The revenue raised via taxation must be sufficient to cover bond payments of $\frac{B}{P}$.

The government's budget constraint is

$$g + \sum_i T_i + \frac{B}{P} \leq \text{Rev}_\theta(\tau) + qB'$$

where

$$\text{Rev}_\theta(\tau) = n\tau w_\theta(\epsilon w_\theta(1-\tau))^\epsilon$$

is the total tax revenue raised by the distortionary labor tax on all n consumers.

Define the budget surplus before transfers as

$$S_\theta(\tau, g, B'; \frac{B}{P}) = \text{Rev}_\theta(\tau) + qB' - g - \frac{B}{P}.$$

The surplus must be large enough to pay for any transfers hence $S_\theta(\tau, g, B'; \frac{B}{P}) \geq \sum_i T_i$. Transfers themselves must be strictly positive: $\forall i \; T_i \geq 0$.

3.3.1 Endogenous Bond Limits

There are endogenous limits to the amount of bonds the government can issue. The upper bound on debt is defined as the maximum amount of bonds the government is able to repay in the case of a recession if it spends nothing on the public good and transfers. Define the upper bound $\overline{B}$ as $\overline{B} = \max_\tau \text{Rev}_l(\tau)$.

The lower bound on debt is the amount of bonds such that the revenue from the bonds would be sufficient to fund optimal public good spending without utilizing the distortionary labor tax. The optimal maximum amount of public good spending is g^s

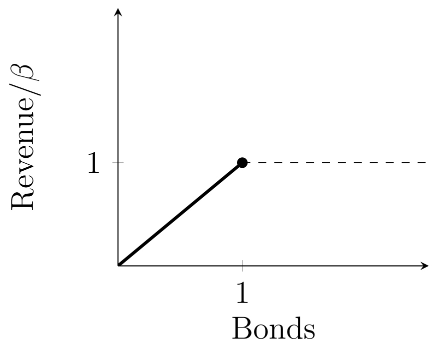

Figure 1: Illustration of Revenue Equivalence for Bonds ≥ 1

such that $\frac{nA}{g^s} = 1$. This equation equates the declining marginal benefit of providing the public good with the opportunity cost of consumers consuming directly. Define $\underline{B}$ as $\underline{B} = -nA$ the level of bonds where one more unit of government spending has the same marginal utility as individual consumption. This is the level of bonds such that the government can finance g^s from interest earnings on the bonds.

3.3.2 Choice Among Revenue Equivalent Bond Levels

There may be a continuum of bond amounts B' that result in the same bond revenue $qB' = E\left[\frac{1}{P(B')}\right]B'$. Issuing bonds above a specific level can result in the expected price level increasing to perfectly offset the amount of revenue the new bonds would raise. For example the pricing function:

$$P = \begin{cases} B', & \text{if } B' \geq 1 \\ 1, & \text{if } B' < 1 \end{cases}$$

results in identical revenue for all bond levels greater than 1.

Two equilibriums with identical bond revenue will be identical with regards to all real variables. To simplify discussion I assume the government issues the minimum amount of bonds necessary for a given level of revenue. The government chooses the bond level B such that

$$\forall k, B = \min_B \{B : qB = k\}$$

3.3.3 Self-Interested Fiscal Policy

Fiscal policy decisions will either be made by a benevolent fiscal authority or a self-interested fiscal authority. A benevolent fiscal authority attempts to maximize the utility of all citizens. A self-interested fiscal authority attempts to maximize the utility of a subgroup of the citizenry. I provide an overview of the political equilibrium I will be examining in this section. A more precise description is included in the analysis of the behavior of the self-interested fiscal authority in Section 4.2.1.

Following the political system laid out in Battaglini and Coate (2008) who extend the political economy model of Baron and Ferejohn (1989), citizens vote each period to decide that period's fiscal policy $\{\tau, g, B, T_i\}$. In a period there are rounds of voting to determine fiscal policy. Each round of voting starts with the power to propose a choice of fiscal policy being randomly assigned to one citizen. The proposer puts forward his policy choices of $\{\tau, g, B, T_i\}$. The proposal is enacted if $m < n$ citizens vote for it. This ends the voting for that period, a new round will begin next period. If the proposal fails the voting round ends and a new round begins. There can be a maximum of T proposal rounds after which a dictator is appointed. The dictator chooses policies unilaterally with the constraint that all transfers T_i must be equal. A fiscal policy proposal defines the fiscal policy for a single period. The next period a new proposer is randomly selected and the process begins anew. Fiscal policy commitment over periods is not allowed.

I focus on a symmetric Markov-perfect equilibrium. These are proposals that depend only on the current state of the economy $\{w_l, w_h\}$ and debt B. They are independent of both the history of the economy and proposal round. Thus we can examine solely on the proposal in the first round.

In order for a proposal to be accepted, the proposal must make the members of the m coalition as well off as the expectation of waiting a round for the next proposal. In practical terms, proposers will select fiscal instruments to maximize the utility of the m citizens in the coalition without care for non-coalition citizens. This is in contrast to the choices of a benevolent fiscal authority who will maximize the utility of all n citizens.

3.4 Monetary Authority

The monetary authority chooses price level P to maximize aggregate welfare. Inflation is costless in this model. The model utilizes timing akin to a Stackelberg game with the monetary authority as leader and the government as follower. The monetary authority chooses P after the shock in each period. Thus monetary policy controls the real value of government debt which is equivalent to consumer wealth.

The choice of timing is deliberate. Briefly, under the alternative timing the fiscal authority won't raise revenue for bond repayment via distortionary taxes because the fiscal authority knows the monetary authority will inflate away the value of any bonds that are issued. Inflation's lump sum tax nature is preferred to the distortionary labor tax. The result is that no nominal bonds are possible to any fiscal authority.[3]This does not resemble the real world.

The monetary authority lacks commitment. Each period the monetary authority chooses the price level for that period only and cannot credibly promise what it will do in the future. Specifically, I constrain the monetary authority to choose the price level solely as a function of the current level of nominal bonds. This is a strong form of the monetary authority's lack of commitment. The monetary authority can only use current variables because strategies that threaten non-optimal ex-post actions, such as trigger strategies, require commitment to maintain the threat. The monetary authority is restricted to the current bond level because that is the only intertemporal good and thus the only thing the monetary authority observes at the beginning of a period. Predicating monetary policy actions on fiscal policy actions that took place in previous or future periods is commitment in another form.

3.4.1 Choice Among Welfare Equivalent Price Levels

There may be a continuum of price levels P that result in identical welfare. I impose two price selection criteria. First, absent welfare gains, the monetary authority will set the price level to 1. This default price level is a normalization. The model has been simplified so prices are not an intertemporal variable. Since bonds are for a single period they depend solely on the ratio of today's price level to tomorrow's. Normalizing today's price to 1 has no real effects.

Second, the monetary authority will only deviate from $P = 1$ for positive welfare

[3]For a more complete explanation see the brief note that concludes the appendix.

gains. When the monetary authority changes the price level, it will minimize $|P-1|$ while maximizing welfare

$$\forall k, P = \arg\min_{P} |P-1| \text{ s.t. } v(B) = k$$

where $v(B)$ will be our welfare function.

This requirement mimics an aversion to inflation and deflation. Together with the behavior of the fiscal authority described in Section 3.3.2, the price selection criteria allow a simplified description of the price level on the equilibrium path without affecting the actual equilibrium.

4 Model Analysis

4.1 The Benevolent Fiscal Authority's Problem

A benevolent fiscal authority tries to maximize total welfare. Since consumers are identical this is equivalent to maximizing the utility of a single consumer. The benevolent fiscal authority's problem can be written as

$$\max_{\tau, g, B', \{T_i\}_1^n} W_\theta(\tau, g) + \frac{\sum_i T_i}{n} + \beta \left[\pi v_H\left(B'\right) + (1-\pi) v_L\left(B'\right)\right]$$

$$\text{s.t.} \quad \begin{aligned} & T_i \geq 0 \ \forall i, S_\theta(\tau, g, B'; \frac{B}{P}) \geq \sum_i^n T_i, B' \in \left[\underline{B}, \overline{B}\right], \\ & \forall k \ B' = \min\{B' : qB' = k\} \end{aligned}$$

The first constraint is that the surplus must be weakly positive. Any surplus will be distributed to citizens as a transfer with each citizen receiving an equal share. The second constraint keeps the level of bonds between the two boundary values as explained in Section 3.3.1. The third constraint selects the minimal B in every level set of revenue as described in Section 3.3.2.

The first order conditions of this problem are

$$\begin{aligned} \frac{1-\tau}{1-\tau(1+\epsilon)} &= \frac{nA}{g} \\ \frac{1-\tau}{1-\tau(1+\epsilon)} &= -n\beta\left[\pi v_H'\left(B'\right) + (1-\pi) v_L'\left(B'\right)\right] \end{aligned}$$

The expression $\frac{1-\tau}{1-\tau(1+\epsilon)}$ is the marginal distortionary cost of non-linear taxation. The first equation equates the marginal cost of raising an additional unit of revenue with the marginal benefit of spending that revenue on public goods. The second equation equates the marginal cost of raising an additional unit of revenue via taxation with the marginal cost of raising the revenue by issuing bonds (and thus smoothing the cost of taxation by pushing it into the future).

The monetary authority chooses P to maximize welfare

$$\max_{P}\left[\begin{array}{ll}\max\limits_{\tau,g,B',\{T_i\}_1^n} & W_\theta(\tau,g)+\dfrac{\sum_i T_i}{n}+\beta\left[\pi v_H\left(B'\right)+(1-\pi)v_L\left(B'\right)\right] \\ \text{s.t.} & T_i\geq 0\ \forall i, S_\theta(\tau,g,B';\dfrac{B}{P})\geq\sum\limits_{i}^{n}T_i, B'\in\left[\underline{B},\overline{B}\right], \\ & \forall k\ B'=\min\{B':qB'=k\}\end{array}\right]$$

Combining the monetary and fiscal authority's problems and simplifying we can write this recursively for a given bond level B as[4]

$$v_\theta(B)=\max_{P}\left[\begin{array}{ll}\max\limits_{\tau,g,B'} & W_\theta(\tau,g)+\dfrac{S_\theta(\tau,g,B';\frac{B}{P})}{n}+\beta\left[\pi v_H\left(B'\right)+(1-\pi)v_L\left(B'\right)\right] \\ \text{s.t.} & S_\theta(\tau,g,B';\dfrac{B}{P})\geq 0, B'\in\left[\underline{B},\overline{B}\right] \\ & \forall k\ B'=\min\{B':qB'=k\}\end{array}\right]$$
$$\text{s.t}\ \forall k\ P=\arg\min_{P}|P-1|\ \text{s.t.}\ v(B)=k$$

The monetary authority's response function $P(B)$ is

$$P(B)=\begin{cases}\infty, & \text{if } B>0\\ (0,\infty), & \text{if } B=0\\ \min\{1,\frac{B}{\underline{B}}\}, & \text{if } B<0\end{cases}$$

At the beginning of a period the monetary authority will face three possibilities for the level of nominal bonds: a positive amount of nominal bonds (the government is in debt), no nominal bonds, or a negative amount of nominal bonds (the government

[4]The following equation includes the equilibrium selection conditions described in Sections 3.3.2 and 3.4.1. For clarity and conciseness future repetitions of similar equations will not be written with these conditions.

is owed money). For a positive amount of nominal bonds, the monetary authority erases the real value of the bonds by setting the price level to infinity. This allows the benevolent fiscal authority to lower taxes since it no longer needs the revenue to pay off any bonds. Because taxes are distortionary lower taxes translates into higher welfare.

If there are no nominal bonds, the price level is indeterminate. Bonds are the only nominal quantity in the maximization problem. If there are no bonds the price level does not matter. If there are negative bonds, the monetary authority will deflate, if necessary, causing the real value of society's debt to equal the Samuelson level $\underline{B}$ where all future distortionary labor taxes are zero and government spending is constant at the optimum.

Claim 1 *The benevolent fiscal authority's solution is to issue 0 bonds to raise 0 revenue in every period or to purchase $\underline{B}$ bonds in the first period and 0 bonds thereafter.*

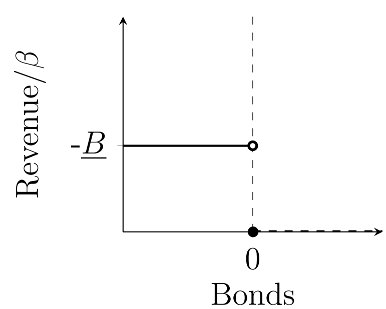

Figure 2: Revenue with a Benevolent Fiscal Authority

The behavior of the monetary authority drives the result. The benevolent fiscal authority is unable to issue bonds because the monetary authority will erase their real value every period. Thus there will be no bonds available for tax smoothing.

As shown by Aiyagari et al. (2002) and Battaglini and Coate (2008), the fiscal authority would optimally have a negative level of bonds. This allows the government funds itself through lump sum taxation via bond remittances rather than distortionary labor taxation to. In those papers the government accumulates a stockpile of real bonds over time.

In this paper the word 'accumulate' is inappropriate: all bonds must be stockpiled by the government in a single period. If the citizens hold any negative amount of bonds the monetary authority will deflate until the real value of those bonds equals the Samuelson level $\underline{B}$. Hence consumers will demand compensation for negative bonds immediately; there will be no time to accumulate a stockpile. In that period, distortionary taxes would be extremely high to fund the bond purchases. This would have a tremendous negative welfare impact that may not be offset by the lowered cost of revenue in the future.[5]

4.2 The Self-Interested Fiscal Authority's Problem

4.2.1 Definition of Self-Interested Fiscal Authority's Problem

Following the outline of Barseghyan et al. (2013), I focus on a symmetric Markov-perfect equilibrium. These are proposals that depend solely on the current state of the economy $\{w_l, w_h\}$ and debt B. They are independent of both the history of the economy and proposal round. A citizen is presumed to vote for a proposition if it makes him at least as well off as waiting for the next proposal round will. I choose equilibria where proposals in each round are voted for by the necessary $m-1$ citizens. This means that the equilibrium path consists of a single round with a single proposal that is voted for by the necessary citizens.

The equilibrium is a set of fiscal proposals for each round $r \in 1, \ldots, T$ for the tax rate, public good spending, bond level and transfers $\{\tau^r, g^r, B'^r, T_i^r\}$. The transfers will be used to convince $m-1$ other citizens to support the proposal. Revenue not spent on transfers or public good spending is the effective transfer to the proposer. An equilibirum defines a value function for each round $v_\theta^r(B)$ representing the expected continuation payoff value for a citizen. The last value function $v_\theta^{T+1}(B)$ is the result of the default proposal by the dictator appointed after round T.

Given a set of value functions $\{v_\theta^r(B)\}_{r=1}^{T+1}$ the fiscal proposals must satisfy the proposer's maximization problem. Similarly the fiscal proposals define the optimal value functions. I start with the first relationship. Since the first proposal in the first round is accepted, I drop the r superscripts for simplicity. Formally, given the value functions the fiscal proposals can be written as

[5] Specifically the tradeoff is dependent on the discount rate β which governs the tradeoff between immiseration today vs. the lack of distortion for the infinite future, the elasticity of labor ϵ which controls the distortionary effect of taxation, and the size of the shocks w_h, w_l which necessitate tax smoothing.

$$\max_{\tau,g,B',T_i} W_\theta(\tau,g) + S_\theta(\tau,g,B';\frac{B}{P}) - (m-1)T_i + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right]$$

$$\text{s.t.} \quad \begin{aligned} & W_\theta(\tau,g) + T_i + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right] \geq v_\theta^{r+1}(B) \\ & T_i \geq 0 \ \forall i, S_\theta(\tau,g,B';\frac{B}{P}) \geq (m-1)T_i, B' \in \left[\underline{B}, \overline{B}\right], \\ & \forall k \ B' = \min\{B' : qB' = k\} \end{aligned}$$

The first constraint is the incentive compatibility constraint that states the proposal must make those citizens receiving a transfer at least as well off as if they wait for the next proposal round. The other constraints force the proposal to be feasible for the government's budget constraint.

Given the fiscal proposals, the value functions are determined by[6]

$$v_\theta(B) = W_\theta(\tau,g) + \frac{S_\theta(\tau,g,B';\frac{B}{P})}{n} + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right]$$

This expression comes from the three possibilities for a citizen in a given proposal round. The first possibility occurring with probability $1/n$ is that a citizen is the proposer and thus receives the surplus after transfers. The second possibility occurring with probability $\frac{m-1}{n}$ is that the citizen is not the proposer but is a member of the randomly selected coalition that votes for the proposal and thus receives the transfer T_i. The third possibility occurring with probability $\frac{n-m}{n}$ is that the citizen is not in the proposer's coalition and receives no transfer. Since utility is linear, the expected utility in a given round is above.

Because the first proposal is accepted in each round and those proposals will be identical, the value functions will be identical for every proposal round $1,\ldots,T$. If the round T proposal is rejected, the round $T+1$ dictator's proposal will result in the value function

$$v_\theta^{T+1}(B) = \max_{\tau,g,B'} W_\theta(\tau,g) + \frac{S_\theta(\tau,g,B';\frac{B}{P})}{n} + \beta\left[\pi v_H(B') + (1-\pi)v_L(B')\right]$$

subject to uniform transfers and the same feasibility constraints as before.

[6]It's helpful to remember that P is a function of the current amount of bonds $P = P(B)$ as are all other fiscal choices. Specifically, $S_\theta(\tau,g,B';\frac{B}{P})$ can be written as $S_\theta(\tau,g,B';P(B))$ to highlight that B is the only state variable.

Definition 1 *An equilibrium is well-behaved if the value function* v_θ *is continuous and concave on the domain* $\left[\underline{B}, \overline{B}\right]$.

I characterize this equilibrium in the next section and prove its existence in the appendix.

4.2.2 Characterization of Self-Interested Fiscal Authority's Problem

A proposer of fiscal policies has to get $m > \frac{n}{2}$ votes for the proposal. Counting the proposer's own vote, $m-1$ other votes are needed. In order to get those votes, the proposer's policies attempt to maximize the utility of the $m-1$ randomly chosen citizens as well as his own. The self-interested fiscal authority's problem is

$$\begin{aligned}
&\max_{\tau,g,B',\{T_i\}_1^n} W_\theta(\tau,g) + \frac{\sum_i T_i}{m} + \beta\left[\pi v_H\left(B'\right) + (1-\pi)v_L\left(B'\right)\right] \\
&\text{s.t.} \quad \begin{array}{l} T_i \geq 0\ \forall i, S_\theta(\tau,g,B';\dfrac{B}{P}) \geq \displaystyle\sum_i^n T_i, B' \in \left[\underline{B}, \overline{B}\right], \\ \forall k\ B' = \min\{B' : qB' = k\} \end{array}
\end{aligned}$$

The monetary authority chooses P to maximize welfare

$$\max_P \left[\begin{aligned}
&\max_{\tau,g,B',\{T_i\}_1^n} W_\theta(\tau,g) + \frac{\sum_i T_i}{m} + \beta\left[\pi v_H\left(B'\right) + (1-\pi)v_L\left(B'\right)\right] \\
&\text{s.t.} \quad \begin{array}{l} T_i \geq 0\ \forall i, S_\theta(\tau,g,B';\dfrac{B}{P}) \geq \displaystyle\sum_i^n T_i, B' \in \left[\underline{B}, \overline{B}\right], \\ \forall k\ B' = \min\{B' : qB' = k\} \end{array}
\end{aligned}\right]$$

The self-interested fiscal authority's optimization problem differs only in potential transfers. If there are no transfers, the problem is identical to that of the benevolent fiscal authority hence the optimal choices are identical. If there are transfers the first order conditions are

$$\begin{aligned}
\frac{n}{m} &= \frac{1-\tau^*}{1-\tau^*(1+\epsilon)} \\
\frac{n}{m} &= \frac{nA}{g^*} \\
{B'}^* &= \arg\max_{B'}\left[\frac{qB'}{m} + \beta\left[\pi v_H\left(B'\right) + (1-\pi)v_L\left(B'\right)\right]\right]
\end{aligned}$$

The left hand side $\frac{n}{m}$ term represents the amount each individual in the governing coalition will receive as a transfer from an additional unit of revenue from every consumer. The first equation shows the marginal benefit to coalition members from additional revenue is equal to the marginal cost of raising that additional unit by distortionary taxation. The second equation displays the choice of the government to spend revenue: the marginal benefit of transfers to the governing coalition is equal to the marginal benefit from using that revenue on public good spending. The third equation chooses the optimal amount of bonds to issue to fund increased transfers versus the cost of increased bonds in the next period.

Note that $\{\tau^*, g^*, B^{'*}\}$ are constants. When there are transfers the tax rate, government spending, and level of bonds will be constant. The government will raise revenue from taxes τ^* and bonds $B^{'*}$. It will spend g^* on the public good. Whatever revenue is left over after that spending is used to fund transfers.

The self-interested fiscal authority's problem can be written recursively and simplified to resemble that of the benevolent fiscal authority

$$v_\theta(B) = \max_P \left[\begin{array}{ll} \max\limits_{\tau,g,B'} W_\theta(\tau,g) + \dfrac{S_\theta(\tau,g,B';\frac{B}{P})}{n} + \beta\left[\pi v_H\left(B'\right) + (1-\pi)v_L\left(B'\right)\right] & \\ \qquad\qquad \tau \geq \tau^*, g \leq g^*, B' \in \left[B'^*, \overline{B}\right] & \\ \text{s.t.} & \\ \qquad\qquad S_\theta(\tau,g,B';\dfrac{B}{P}) \geq 0, \forall k \; B' = \min\{B' : qB' = k\} & \end{array} \right]$$

The new constraints are limits on the lowest taxes, highest government spending and least bonds. If there are transfers, these variables will be equal to the starred value.

We can determine when there will be transfers. If the revenue from taxes τ^* and bonds $B^{'*}$ is sufficient to cover spending g^* on the public good, there will be transfers. Thus there is a cutoff

$$C_\theta = \text{Rev}_\theta(\tau^*) + qB'^* - g^*$$

which is the level of bonds such that $S_\theta(\tau^*, g^*, B'^*; C_\theta) = 0$. If the current level of bonds in the period is above C_θ there will be no revenue for transfers thus the optimization problem is identical to that of the benevolent fiscal authority. If the current level of bonds is below C_θ there will be revenue for transfers while taxes, public good spending and bond issuance are $\{\tau^*, g^*, B^{'*}\}$ respectively.

The monetary authority chooses P[7] to maximize welfare

$$P(B) = \begin{cases} \frac{B}{C_\theta}, & \text{if } B > C_\theta \\ 1, & \text{if } B < C_\theta \end{cases}$$

If the level of nominal bonds is less than the bond cutoff that means there are transfers. If the monetary authority were to increase the price level, the amount of debt the self-interested fiscal authority owed would go down. The revenue the self-interested fiscal authority had directed to bond repayment would instead go to transfers while taxes and government spending would remain constant at τ^* and g^*. This would not increase welfare hence the monetary authority keeps the price level constant.

If the level of nominal bonds is greater than or equal to the bond cutoff there are no transfers. The self-interested fiscal authority's optimization problem is identical to that of the benevolent fiscal authority. The monetary authority's choice is also identical: erase the real value of bonds by increasing the price level as long as the fiscal authority will use the extra revenue to decrease taxes rather than increase transfers.

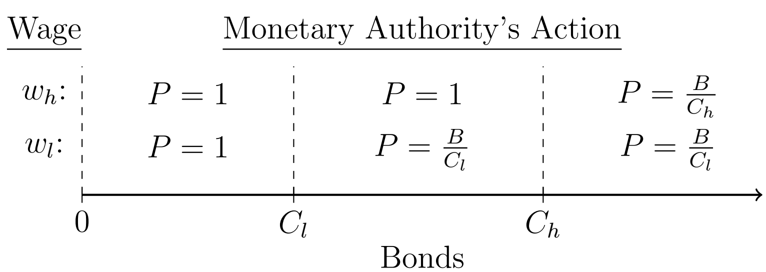

Figure 3: The Monetary Authority's Decision with a Self-Interested Fiscal Authority

Claim 2 *The self-interested fiscal authority's solution is to issue C_h bonds that raise $\beta(\pi C_h + (1-\pi)C_l)$ revenue in every period.*

[7]This pricing requires $C_\theta \geq 0$. (If $C_\theta = 0$ the second condition would need to be $P = \infty$, if $B > C_\theta$) The issue arises because the monetary authority can't change a positive level of bonds into a negative one (nor vice-versa) since $P > 0$. $C_\theta < 0$ implies that even if the government accumulated a surplus there would be no transfers; an unlikely situation. Also note that introducing the self-interested fiscal authority solves the indeterminacy problem that bedevils the benevolent fiscal authority's problem.

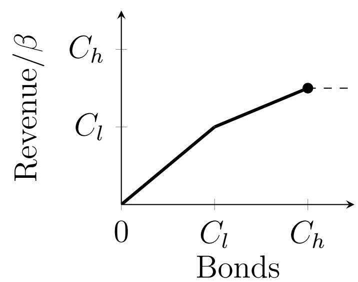

Figure 4: Revenue with a Self-Interested Fiscal Authority

The self-interested fiscal authority issues C_h bonds because that level maximizes the amount of revenue raised while holding taxes and government spending at their starred values. Issuing more bonds raises no additional revenue because the monetary authority will inflate away those bonds no matter the wage realization. If the self-interested fiscal authority issues less than C_h bonds it is foregoing revenue that would be available if there is a good realization of the wage.

To clarify the equilibrium as much as possible: on the equilibrium path, the fiscal authority will always issue C_h bonds while setting taxes to τ^* and public good spending to g^*. The monetary authority will choose $P = 1$ if the wage shock is w_h and will choose $P = \frac{C_h}{C_l}$ if the wage shock is w_l.

The monetary authority uses revenue from the lump sum inflation tax to perfectly smooth taxes across periods. For any realization of the wage shock and any bond level, taxes will be constant at τ^* and government spending constant at g^*. These are the lowest possible taxes and highest possible spending and thus lead to the highest possible welfare.

4.3 Main Results

Proposition 1 *A self-interested fiscal authority is able to support a positive level of nominal bonds while a benevolent fiscal authority is unable to do so.*

Claims 1 and 2 serve to establish this result. A benevolent fiscal authority paired with a monetary authority will be unable to raise revenue by issuing nominal bonds. Changing the benevolent fiscal authority to a self-interested fiscal authority allows the fiscal authority to raise revenue by issuing nominal bonds.

I now compare the welfare effects of price level commitment to the alternative of discretionary monetary policy.

Definition 2 *Price level commitment is defined as $P = k$ for some k for all periods*[8]*. Discretionary monetary policy is defined as $P = P(B)$ at the start of every period.*

This definition of price level commitment is equivalent to the fiscal authority issuing indexed rather than nominal bonds. The monetary authority has no control over the price level. Due to the restrictions on the monetary authority's price function discussed in Section 3.4 this is the natural definition of price level commitment. Commitment to a non-constant pricing function $P(B)$ other than the ones derived above in Section 4 will result in lower welfare by construction.

Proposition 2 *Price level commitment by a monetary authority with a self-interested fiscal authority and nominal bonds results in lower welfare than discretionary monetary policy.*

Claim 2 shows that discretionary monetary policy leads to the lowest tax rate τ^* and highest public good spending g^* possible. The monetary authority uses revenue from the lump sum inflation tax rather than the distortionary labor tax to repay bonds. To prove Proposition 2 I need to establish that price level commitment leads to taxes and government spending that are not τ^*, g^* for at least single period. The situation with price level commitment is is similar to Barseghyan et al. (2013); the main difference is that shocks in this paper are not persistent.

Intuitively, with price level commitment the self-interested fiscal authority will issue (what will be ex-post) too many bonds because it doesn't know the realization of tomorrow's productivity shock. The benefit of bonds is that they increase transfers today, the cost is the possibility that repaying the bonds will require higher taxes tomorrow. If the shock is w_h the tax rate τ^* will raise enough revenue to repay the bonds. If the shock is w_l, the tax rate τ^* won't raise enough revenue to repay the bonds thus necessitating higher taxes. Higher distortionary means lower welfare.

[8] The requirement that commitment holds for all periods is unnecessary but simplifying for what follows; price commitment commitment of any length suffices.

5 Optimal Design of Monetary, Fiscal Structure

The model presented in the previous section is useful to explain why the monetary and fiscal structure of modern advanced economies looks similar. A government subject to elections controls fiscal policy. A central bank independent from the voting process is tasked with controlling the price level. The vast majority of government debt is nominal.

Proposition 3 *The pairing of a self-interested fiscal authority and an independent monetary authority with nominal bonds and discretionary policy is the solution to a real world constrained mechanism design problem that results in the highest welfare.*

The mechanism design problem is to choose the structure of the economy to maximize welfare. This can be viewed as a constitutional design problem: what would citizens choose in a period 0 before knowing whether they are members of the governing coalition in period 1. There are two options for the fiscal authority: benevolent or self-interested. There are two options for the monetary authority: independent or what I will call captured. There are two options for bonds: indexed (equivalent to price level commitment) or nominal. If bonds are indexed control of the monetary authority is irrelevant since the monetary authority has no choices to make

Amongst the six possible combinations, the combination resulting in the highest welfare has a benevolent fiscal authority and real bonds. As shown in Aiyagari et al. (2002) and Battaglini and Coate (2008), this combination will accumulate a stock of assets and use the interest revenue to smooth taxes. However, in the real world dictatorships do not issue indexed bonds due to the inability of a dictator to make contracts enforceable across regimes among other issues. Additionally, it's very hard to find a benevolent dictator.

Definition 3 *A captured monetary authority is a monetary authority that is not independent. It will be controlled by the same microfounded political process as a self-interested fiscal authority. Namely it tries to maximize the utility of m out of n consumers.*[9]

[9]The captured monetary authority's m coalition does not need to be identical to the fiscal authority's m coalition though for simplicity this is discussed here

A captured monetary will set the price level to infinity for any positive level of nominal bonds. Above the bond cutoff C_θ, increasing the price level will result in decreased taxes as discussed previously. The new result is that for a captured monetary authority increasing the price level below the bond cutoff will result in positive welfare gains. Previously the independent monetary authority saw no change in welfare when the level of bonds was below the cutoff. The increased transfers that result from increasing the price level were perfectly offset by the decreased wealth of all the citizens. The captured monetary authority only cares about those receiving the transfers so the welfare gain from increasing the price level is positive. See the proof of Proposition 3 in the Appendix.

Comparing the four available combinations, choosing a self-interested fiscal authority, an independent monetary authority, and nominal bonds is optimal. This is the design illustrated in Proposition 2. I briefly describe and compare the other combinations to this one below.

1. Benevolent Fiscal, Benevolent Monetary, Nominal Bonds: This combination is unable to support a positive level of nominal bonds due to the time inconsistency problem. There will be no tax smoothing.

2. Benevolent Fiscal, Captured Monetary, Nominal Bonds: This combination is unable to support any nominal bonds due to the time inconsistency problem. There will be no tax smoothing.

3. Self-Interested Fiscal, Benevolent or Captured Monetary, Indexed Bonds: This combination is explored in Proposition 2 and shown to result in lower welfare than if it featured nominal bonds.

4. Self-Interested Fiscal, Captured Monetary, Nominal Bonds: This combination is unable to support any nominal bonds due to the time inconsistency problem. There will be no tax smoothing.

Since the setup featuring a self-interested fiscal authority and an independent monetary authority with nominal bonds is welfare maximizing, it's natural we observe it in the real world. As with the choice to use nominal bonds, citizens in an original position would choose this structure; possibly by embedding it in the constitution of the state.

This analysis presupposes that nominal bonds are the only intertemporal savings instrument available. Taking one step back, it's necessary to explain why nominal bonds will exist instead of real bonds. There are two ways to justify nominal bonds. As shown by Proposition 2 welfare is higher with nominal bonds. If citizens in an original position, before the first period coalition is chosen, were able to vote on nominal or real bonds they would choose solely nominal.

The second way is to assign responsibility for choosing real or nominal bonds to the monetary authority. The fiscal authority chooses the amount of bonds, but the type is chosen by the monetary side. The monetary authority seeks to maximize overall utility which is is higher under nominal bonds. Hence it will insist on nominal instead of real.

6 Conclusion

Price commitment is a dangerous thing. Discretionary monetary policy keeps fiscal policy in line; monetary commitment gives the fiscal authority the power to ignore monetary constraints. Counterintuitively, giving the monetary authority commitment lessens its power over the fiscal authority to the detriment of overall welfare.

This paper shows that monetary policy benefits from distorted fiscal policy. Without an explicit commitment mechanism, nominal bonds are possible only if fiscal policy is self-interested. Although the utility functions of the monetary and fiscal authorities will differ, the overall result is better for the monetary authority's goal of maximizing welfare than when they are identical.

The source of the welfare gain is a desire by the monetary authority to avoid what it views as waste. Eliminating the debt burden of a self-interested fiscal authority leads to wasteful spending. Controlling the self-interested fiscal authority also provides the justification for nominal bonds. Indexed bonds, as in the case of price level commitment, allow a self-interested fiscal authority to act without constraint. If the power to choose the type of bonds is vested in either the monetary authority or citizens, they will choose nominal bonds.

Without an independent monetary authority this structure collapses. Control of both fiscal and monetary policy decisions doesn't provide control over the expectations of citizens. The time inconsistency problem returns and nominal bonds are impossible. It's in society's interest for the monetary authority to be independent from the fiscal authority.

The structure of modern economies, where fiscal decisions are controlled by a political entity and monetary decisions by an independent non-political body with nominal bonds and without price commitment, is the efficient choice. It allows some bonds to be issued, but not so many that the political distortion is able to distort optimal policy. All other combinations lead to either too high taxes or no tax smoothing.

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A Appendix

A.1 Proof of Propositions 1 and 2

A.1.1 Proof of Claim 1

I begin by showing Claim 1 that the benevolent fiscal authority suffers from time inconsistency and cannot issue nominal bonds. To do this it suffices to show that

$$P(B) = \begin{cases} \infty, & \text{if } B > 0 \\ (0, \infty), & \text{if } B = 0 \\ \frac{B}{\underline{B}}, & \text{if } \underline{B} < B < 0 \\ 1, & \text{if } B \leq \underline{B} \end{cases}$$

Concentrating on the case of $B > 0$, I show

$$\frac{\partial v_\theta(B)}{\partial P} = \left[\frac{\epsilon \tau(\frac{B}{P})}{1 - \tau(\frac{B}{P})(1+\epsilon)} \right] \frac{B}{nP^2}.$$

This expression is always positive hence there's always a benefit to increasing the price level.

To find this, choose $B_0 > 0$. I will build a non-optimal function $\phi(B)$ that equals $v(B)$ at B_0 but is less elsewhere (and strictly concave). This will fulfill the conditions of Theorem 4.10 of Stokey et al. (1989) stating that derivates of $\phi(B)$ are equal to that of $v(B)$ at B_0. For clarity and notational simplicity let $b = \frac{B}{P(B)}$ and $b_0 = \frac{B_0}{P(B_0)}$.

Choose B from a neighborhood of B_0. Define

$$g(b) = \text{Rev}\left(\tau(b_0)\right) + qB'(b_0) - b$$

which is a non-optimal amount of government spending while still fulfilling debt repayment obligations. The amount of transfers will be the residual after paying back b bonds

$$S_\theta(\tau_\theta(b_0), g(b), B'(b_0); b) = \text{Rev}\left(\tau(b_0)\right) + qB'(b_0) - g(b) - b$$

Define the non-optimal utility function to be

$$\phi(B) = W\left(\tau(b_0), g(b)\right) + \frac{S_\theta(\tau_\theta(b_0), g(b), B'(b_0); b)}{n} + \beta\left[\pi v_H\left(B'(b_0)\right) + (1-\pi) v_L\left(B'(b_0)\right)\right]$$

Expand the indirect utility and transfers terms. Note that the terms dependent on P are the direct utility benefit of government spending, the bond holdings of the household in the current period, and transfers. Differentiate, noting that the terms dependent on $P(B)$ in transfers will cancel, and find

$$\begin{aligned}
\frac{\partial \phi(B)}{\partial P} &= -\frac{B}{P^2} + \frac{A}{g}\left(\frac{B}{P^2}\right) \\
&= -\frac{B}{P^2} + \left[\frac{1-\tau\left(\frac{B}{P}\right)}{1-\tau\left(\frac{B}{P}\right)(1+\epsilon)}\right]\left(\frac{B}{nP^2}\right) \\
&= \left[\frac{\epsilon\tau\left(\frac{B}{P}\right)}{1-\tau\left(\frac{B}{P}\right)(1+\epsilon)}\right]\left(\frac{B}{nP^2}\right)
\end{aligned}$$

where I've substituted in the first order condition of the fiscal authority. Taking the second derivative confirms the necessary conditions. A similar construction proves the case for $B < 0$.

I follow the outline of Barseghyan et al. (2013) (specifically Propositions 1, 2 and 3) to show the value functions are properly defined and converge. Note that the value functions in this paper are almost identical to those in Barseghyan et al. (2013). The addition of the monetary authority will effectively restrict the domain of possible bonds to $[\underline{B}, C_h]$.

Showing that the self-interested fiscal authority's problem is equivalent to

$$v_\theta(B) = \max_P \left[\begin{array}{c} \max\limits_{\tau,g,B'} W_\theta(\tau, g) + \dfrac{S_\theta(\tau, g, B'; \frac{B}{P})}{n} + \beta\left[\pi v_H\left(B'\right) + (1-\pi) v_L\left(B'\right)\right] \\ \text{s.t.} \quad \begin{array}{c} \tau \geq \tau^*, g \leq g^*, B' \in \left[B'^*, \overline{B}\right] \\ S_\theta(\tau, g, B'; \dfrac{B}{P}) \geq 0, \forall k \ B' = \min\{B' : qB' = k\} \end{array} \end{array}\right]$$

follows from the bond cutoff C_θ. If bonds are below C_θ the first order conditions set $\{\tau^*, g^*, B^*\}$ and the excess revenue is transferred to the m coalition. With linear utility splitting 1 dollar of transfers amongst m citizens has the same overall utility effect as splitting 1 dollar amongst n citizens.

If bonds are above or equal to C_θ our problem is identical to benevolent fiscal policy. At C_θ our constraints just bind to $\{\tau^*, g^*, B^*\}$. Derivatives $\frac{\partial \tau}{\partial B} \geq 0, \frac{\partial g}{\partial B} \leq 0$ so for bonds above C_θ we have $\tau \geq \tau^*, g \leq g^*$.

To show that the value function and optimal bond level are characterized by the first order conditions I duplicate the proofs from Barseghyan et al. (2013). First assume the optimal bond level solves the value function given the value function. By backwards induction on period $T+1$ where the dictator is appointed it's easy to show that they will coincide in the first round. On the other hand showing that the optimal bond level solves the value function is a proof by contradiction. Namely any value other than the optimal bond level leads to lower transfers or higher taxes on the proposer. The existence of an equilibrium comes from showing the value function is a contraction for all values of bonds.

A.1.2 Proof of Claim 2

It remains to show that

$$P(B) = \begin{cases} \frac{B}{C_\theta}, & \text{if } B \geq C_\theta \\ 1, & \text{if } B < C_\theta \end{cases}$$

I follow the same steps as with a benevolent fiscal authority. The first order condition for the monetary authority with a self-interested fiscal authority is

$$\frac{\partial v_\theta(B)}{\partial P} = \begin{cases} \left[\frac{\epsilon \tau_\theta(\frac{B}{P})}{1-\tau_\theta(\frac{B}{P})(1+\epsilon)}\right] \frac{B}{nP^2}, & \text{if } B > C_\theta \\ 0, & \text{if } B < C_\theta \end{cases}$$

If $\frac{B}{P} \geq C_\theta$ the self-interested fiscal authority's problem is identical to the benevolent fiscal authority's problem hence the derivative is equal. When $\frac{B}{P} < C_\theta$ the derivative can be taken directly from the definition of $v(B)$. Increasing the price level causes no change in taxes or government spending (which are pegged at τ^*, g^*). It will redistribute income gained from the inflation tax on all n consumers into transfers to the m in the coalition. Because utility is transferable overall welfare is identical.

The derivative establishes that $v(B)$ is maximized on $B < C_\theta$. It is easy to see the value function is flat for all $B \leq C_\theta$. By definition at C_θ and below the tax rate, public good spending and bond issuance are (τ^*, g^*, B'^*). As explained above, lower bonds means less wealth but more transfers. The two effects offset hence $v(B)$ is also maximized at the bound C_θ.

To compose the pricing function, notice welfare increases until the level of bonds falls to C_θ. Pushing the level of bonds below C_θ has no effect on welfare

$$v_\theta(B) = k \ \forall P \in \left[\frac{B}{C_\theta}, \infty\right]$$

Claim 2 says that a self-interested fiscal authority will issue C_h bonds. Revenue from issuing bonds either lowers the current tax rate or increases transfers. Both of these result in higher utility for the self-interested fiscal authority. Hence the self-interested fiscal authority will attempt to maximize bond revenue. This is done by issuing C_h bonds. Bonds greater than C_h will be inflated away, bonds less than C_h would forego revenue if tomorrow has high productivity.

Assume the self-interested fiscal authority issues $C_l < B^0 < C_h$ bonds. There are two possibilities for the next period. If the shock is w_h, P' will be 1. If the shock is w_l, $P' = \frac{B^0}{C_l}$ hence the real amount of bonds will be C_l. Comparatively, if the self-interested fiscal authority issues C_h bonds the price level tomorrow will be 1 if the shock is w_h. If the shock is w_l, $P' = \frac{C_h}{C_l}$ hence the real amount of bonds tomorrow will be C_l.

The value function is identical at these two points tomorrow hence the consequences for the self-interested fiscal authority today are identical. Members of the coalition today don't know whether they will be members tomorrow. Since $B^0 < C_h$ the self-interested fiscal authority will issue C_h bonds to gain transfers today without changing the continuation value.

Proposition 1 is proved by comparing the optimal pricing functions of Claims 1 and 2. The benevolent fiscal authority can issue either 0 bonds or must immediately issue the Samuelson level $\underline{B}$. In the former case there is autarky period to period. In the latter labor taxes will be 0

To prove Proposition 2 I need to show that with price level commitment the tax level will deviate from the minimum τ^* for a single period. The model with price level commitment is equivalent to a simplified version of Barseghyan et al. (2013). See the paper for an in-depth description of the dynamics of the model. Without a monetary authority to keep debt at the proper cutoff C_θ, debt will exceed the cutoff, specifically it will do so in periods of low realizations of the productivity shock. A self-interested fiscal authority will attempt to fund transfers today by counting on a high realization tomorrow to fund bond repayment. When there is a low productivity shock taxes will exceed the minimum values established previously.

A.2 Proof of Proposition 3

The only new part of this proposition is that an independent monetary authority is superior to a captured monetary authority. I proceed as before to differentiate the value function with respect to P to determine optimal behavior.

If the fiscal authority is benevolent, the optimal price setting of a captured monetary authority is identical to that of an independent monetary authority. Namely, decreasing the real value of bonds means taxes decline and government spending increase. The reasoning, construction of the derivative and pricing function are identical to Proposition 1. The benevolent fiscal authority will be unable to issue any nominal bonds.

If the fiscal authority is self-interested, the derivative of the self-interested monetary authority's value function with respect to P is

$$\frac{\partial v(B)}{\partial P} = \begin{cases} \left[\frac{\epsilon\tau_2(\frac{B}{P})}{1-\tau_2(\frac{B}{P})(1+\epsilon)}\right]\frac{B}{nP^2}, & \text{if } B > C_\theta \\ \left(\frac{n}{m}-1\right)\frac{B}{nP^2}, & \text{if } B < C_\theta \end{cases}$$

The case $B \leq C_\theta$[10]arises from the equivalence of government debt and transfers in a consumer's budget constraint: both are wealth. Receiving a transfer is identical to holding government debt. Increasing the price level decreases nominal government debt that every consumer holds. The total decrease in debt will equal the total increase in transfers to just the coalition that controls the captured monetary authority.

Independent monetary policy weighed this increase averaged across all n consumers compared to the decrease in debt and saw it had no effect. (The derivative was 0 in this region.) For captured monetary policy, those transfers aren't averaged. Increasing the price level decreases the amount the government has to repay everyone while increasing the transfers to just the coalition. It is in effect a lump sum tax on

[10]The value displayed for the case $B < C_\theta$ is correct if the coalition controlling the captured monetary authority is the same as the coalition controlling the self-interested fisal authority. The exact value depends on the overlap between the two coalitions. The captured monetary authority is freeing funds to be used as transfers to the self-interested fiscal authority's coalition.

all to fund direct transfers for the coalition.

The derivative is always positive so there's always a benefit to increasing the price level,

$$P = \begin{cases} \infty, & \text{if } B > 0 \\ (0, \infty), & \text{if } B = 0 \end{cases}$$

Hence a captured monetary authority means that no nominal bonds will be possible.

A.3 Brief Note on Timing

The default timing is that the monetary authority chooses the price level before the fiscal authority chooses fiscal instruments. This timing results in a model that accurately mirrors the real world while the alternative timing does not. I take that as *prima facie* evidence that this is the correct choice.

The alternative timing is that the fiscal authority chooses fiscal instruments before the monetary authority chooses the price level. This timing results in no nominal bonds being possible in the model. The reasoning is that the fiscal authority has a choice at the beginning of every period to raise tax revenue to pay back bonds or allow the monetary authority to inflate away their value. Taxation is distortionary so the fiscal authority will never raise any tax revenue.

The fiscal authority can choose not to raise tax revenue because it knows the monetary authority will raise the price level to equate revenue minus transfers and public good spending to the amount of bonds. The monetary authority must raise P to ensure the government's budget constraint holds.

$$P(B) = \begin{cases} \frac{B}{\mathrm{Rev}_\theta(\tau)+B'-g-\sum_i T_i}, & \text{if } B > 0, \mathrm{Rev}_\theta(\tau) + qB' > g + \sum_i T_i, \\ \infty, & \text{if } B > 0, \mathrm{Rev}_\theta(\tau) + qB' = g + \sum_i T_i, \\ (0, \infty), & \text{if } B = 0 \end{cases}$$

The fiscal authority forces the monetary authority to inflate thus nominal bonds won't be possible. This is a problem of fiscal commitment while the with default timing the paper examines a problem of monetary commitment.

In the default timing the time inconsistency problem is that the monetary authority is unable to commit to a price level thus inflation expectations go to infinity. In the alternative timing the time inconsistency problem is that the fiscal authority is unable to commit to raise the revenue necessary to repay bonds thus inflation expectations go to infinity.